IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Examiner: Name: Regina Liang

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Title: Tracking Motion Using an Interference Pattern

APPEAL BRIEF

Mail Stop Appeal Brief -- Patents
Commissioner for Patents
P.O. Box 1450
Arlington, VA 22313-1450

Sir:

In response to a Final Office Action dated August 10, 2007, Applicants respectfully request entry of this Appeal Brief, and allowance of the presently pending claims in the above-identified patent application.

DATE OF DEPOSIT: February 8, 2008

CERTIFICATE OF ELECTRONIC DEPOSIT: I hereby certify that all paper(s) described herein are being filed electronically with the United States Patent and Trademark Office on the date indicated above and addressed to Mail Stop Appeal Brief - Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Signature: Thomas F. Woods

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I. Real Party in Interest

The Real Party in Interest of the above-referenced patent application is Avago Technologies ECBU IP (Singapore) PTE. Ltd.

II. Related Appeals and Interferences

There are no related appeals or interferences respecting the above-referenced patent application.

III. Status of the Claims

Claims 21-50 remain pending in the present patent application. Claims 1-11, 14-18 and 20-22 are the subject of this appeal, claims 12, 13 and 19 having been previously indicated as being allowable if rewritten in independent form. The particular status of each claim is as follows:

Claims 1 through 20: Cancelled and *not* appealed herein.

Claims 21 through 50: Rejected *and appealed* herein.

Claims that are the subject of this Appeal are presented in the Claim Appendix hereto in their present form.

IV. Status of Amendments

Various amendments to claims 21-24, 27, 28, 30-48 and 50 have been made and entered in the present application as described in detail below. No amendments to the Specification, Drawings or Abstract have been made to the present application since the present application was first filed.

In a Preliminary Amendment and Response Accompanying an RCE mailed December 17, 2006, claims 1-20 were cancelled, and it was requested that new claims 21-49 be added.

In an Office Action mailed March 13, 2007, only claims 21-49 were indicated as being pending. Although the March 13, 2007 paper did not explicitly state that the new claims filed in the December 17, 2006 had been entered and that claims 1-20 had been cancelled, neither did the March 13, 2007 paper indicate that new claims 21-49 and cancellation of claims 1-20 had *not* been entered. In addition, in the March 13, 2007 paper, the Examiner acted on and made substantive arguments in rejecting the claims as they had been cancelled and added in the December 17, 2006 paper, and accordingly applicant's attorney must presume the cancellation and entry of new claims requested in the December 17, 2006 paper were duly entered by the Examiner.

In a Response and Amendment filed June 14, 2007, amendments to claims 21-24, 27, 28 and 30-48 were requested, and the entry of new claim 50 was also requested.

In an Office Action mailed August 10, 2007, only claims 21-50 were indicated as being pending. Although the August 10, 2007 paper did not explicitly state that the amendments requested to claims 21-24, 27, 28 and 30-48, and the entry of new claim 50, in the June 14, 2007 paper had been entered, neither did the August 10, 2007 paper indicate that such claims had not been amended or that new claim 50 had not been entered. In addition, in the August 10, 2007 paper, the Examiner acted on and made substantive arguments in rejecting the claims as they had been amended and added to in the June 14, 2007 paper, and accordingly applicant's attorney must presume the amendments and entry of new claim requested in the June 14, 2007 paper were duly entered by the Examiner.

In an Amendment after Final filed September 7, 2007, amendments to claims 31 and 34 were requested.

In an Advisory Action dated September 20, 2007, the amendments requested in the September 7, 2007 paper were explicitly acknowledged as having been entered. Moreover, claims 21-50 were explicitly acknowledged in the Advisory Action as pending.

V. Summary of the Claimed Subject Matter

A method and device for tracking motion across a surface by creating an interference pattern by reflecting light from the surface are provided. There is produced, as a result of sensor moving across the surface, at least one signal pattern corresponding to a detection of a physical dimension of the interference pattern. This detected dimension is associated with an assumed dimensional value to determine a distance traveled by the sensor.

In one embodiment, there is provided a device for determining a first distance along a movement path on a surface over which an optical tracking device is moved by a user. The device comprises a coherent light source configured to project a first coherent light beam along the movement path and onto the surface as an incident light beam. The coherent light source is configured in respect of the surface to produce a plurality of light interference speckles resulting from the first light beam and a second light representing at least portions of the first light beam reflected form the surface interfering with one another, the speckles having a first average spatial dimension. A plurality of light sensors is arranged in a sensor cluster and operatively associated with the coherent light source and a processor. Each of the plurality of light sensors has a second spatial dimension that is less than the first average spatial dimension of the speckles, and each of the light sensors is further configured to generate a first signal when one of the plurality of speckles is detected thereby and to generate a second signal when one of the plurality of speckles is not detected thereby. The processor is configured to determine the first distance on the basis of the plurality of first and second signals generated by the plurality of light sensors as the device is moved over the surface.

Fig. 1 shows one embodiment using electromagnetic waves (light) for sensing relative movement. The embodiment shown uses a laser to emit coherent light that can be reflected off of a surface. The resulting interference pattern consists of a pattern of light and dark aspects, called speckles, when observed or detected. The dimensions of an individual speckle are primarily a function of certain device parameters, such as the wavelength of the incident light, the diameter of the laser beam, and the distance of the observer or the photo sensor from the reflecting surface. If the light parameters are held constant, an embodiment can anticipate that values for the dimensions of the formed speckles will to within a fixed Gaussian distribution where approximately 95% of the speckles are within 60% in size. Therefore, by holding the parameters constant, one embodiment can be configured to anticipate that 95% of the resulting speckles will have dimensions within some known range of values. If a large number of speckles are used, this consistency may be sufficient to enable a system to count the speckles as they pass and determine the distance of motion across a surface.

FIG. 1

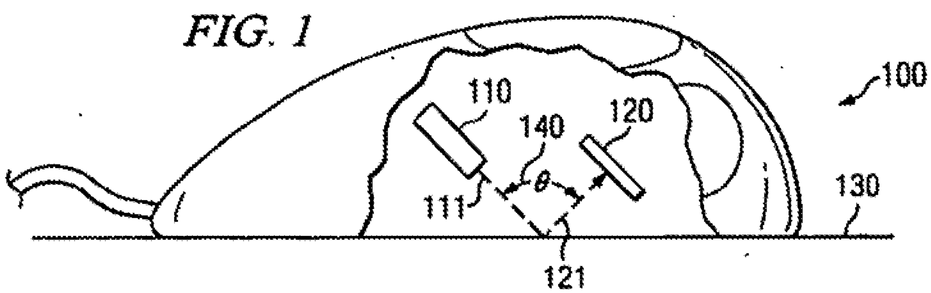


Fig. 1 of the Present Patent Application

When the parameters of wavelength, laser diameter, and detector distance from surface are held constant, various embodiments may be configured to assume that each speckle width (or other appropriate pattern aspect dimension, such as speckle length, the distance between speckles, the distance between the front edge of two speckles, or the distance between the trailing edges of two speckles) is, in fact, the statistical average for that dimension as determined by the arrangement of the system. For average speckle size:

$$\lambda \cdot (R/d) \qquad \text{Eq. (1)}$$

Where λ is wavelength; R is distance from the reflection point; and d is diameter of the beam. As equation (1) shows, the more tightly confined the laser beam used, the larger the speckles will be in the resulting pattern. Thus, it may be possible to create speckles with a predictable Gaussian average of between 50 to 100 microns in size. By equating the average value to the actual size of each speckle, it is possible to calculate the distance traveled by counting the number of speckles that have passed

In the embodiment of Fig. 1, computer mouse 100 holds laser 110 and sensor cluster 120. Laser 110 emits coherent light 111 which reflects off of surface 130 producing interference phenomena, speckles 121. Laser 110 and sensor cluster 120 are held fixed with respect to each other, but the interference pattern 121 will move, with respect to sensor cluster 120, as computer mouse 100 moves across surface 130.

Fig. 3a is a diagram illustrating several aspects of one embodiment in relation to an interference phenomena, such as speckles produced by laser light reflecting off a surface In Fig. 3a, sensor cluster 300 is arranged in accordance with one embodiment Five sensors 301-305 are arranged in a cross pattern with sensor 301 at its center. Sensors 302,303,304 and 305 are then arranged on the points of a compass north, east, south, and west, respectively.

Fig. 3b shows interference pattern 310 composed of speckles, such as speckle 311. In the embodiment depicted, the speckles are designed to be approximately twice the size of sensors 301-305. A typical optical mouse may have 250 or more fairly large sensors in order to accommodate the variation in surfaces a user may use. Sensors as small as 5 microns are currently available, which would result in an entire sensor array less than 50 microns across. If a sensor is used that is smaller than the speckles created, counting the speckles may be easier. By adjusting the distance of the sensors from the scattering surface, the speckle size can be varied, and a distance of 1 to 2 centimeters may be sufficient to produce speckles of5 to 10 microns in size. Some embodiments may use sensors with a diameter of 5 microns, and an average speckle size of approximately 10 microns. At such sizes, approximately 2500 speckles per inch of movement can be detected.

FIG. 3a

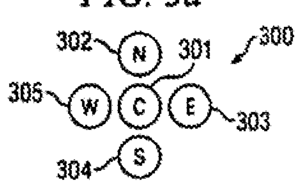
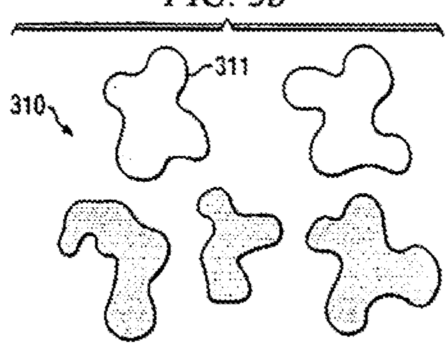


FIG. 3b



Figs. 3a and 3b of the Present Patent Application

In a sensor cluster, direction can be determined by the successive triggering of linked sensors. If only a single sensor is triggered by the presence of a speckle, no information can be gleaned regarding direction. If, however, a speckle triggers first one and then a second of a linked group of sensors, direction can be determined from the arrangement of the linked sensors. The north 302, center 301, and south 304 sensors of Fig. 3a are arranged in a vertical line. In Fig. 3a, if a speckle triggers north sensor 302, then center sensor 301, and then south sensor 304, a determination can be made that mouse 100 is traveling from south to north. A comparison of linked sensors can lead to a positive, negative, or zero direction state. Sensors may be linked along vertical and horizontal lines, and the signals of such linked sensors compared to determine direction states of+1, -1, or 0 along the vertical and the horizontal axes.

Various embodiments may also use a generalized method of navigation as illustrated in the flow diagram of Fig. 7. In step 701, a sensor of the sensor cluster detects the presence of a speckle creating a change (such as a rise) in the signal of the sensor. In step 702, the signals of the linked sensors are queried. In step 703, the signals of linked sensors are compared and a direction state of the sensor cluster is determined. In step 704, the signal of the original or first sensor indicates that the speckle is no longer being detected (a fall in the signal). In step 705, the distance traveled by the mouse is determined by correlating the rise and fall of the signal to the length of an average speckle or other suitable dimension of the interference pattern. Any dimension of an interference pattern can be used to determine mouse direction and movement distance and if a suitable statistical average is obtainable.

FIG. 7

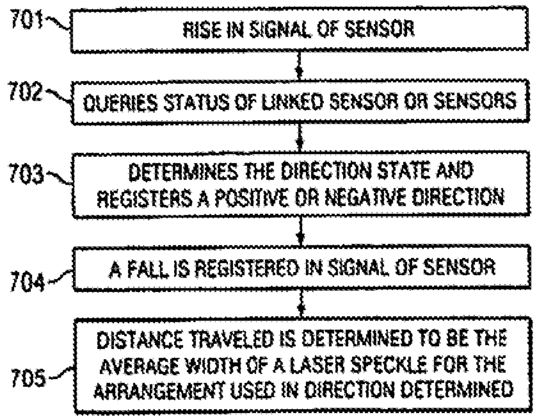


FIG. 4a

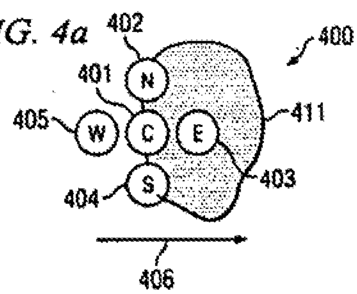


FIG. 4b

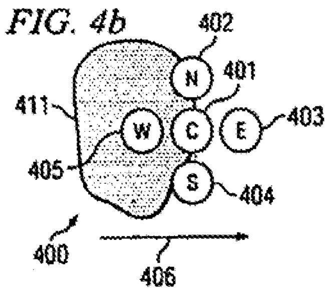
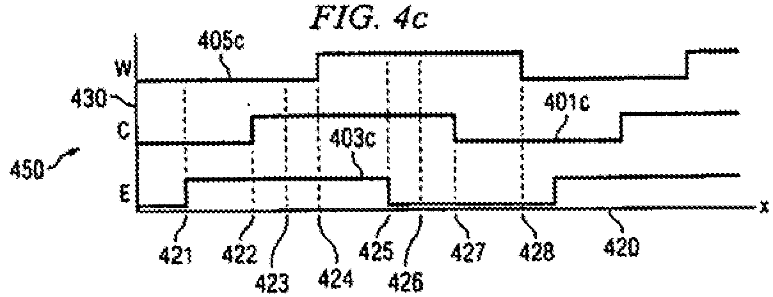


FIG. 4c

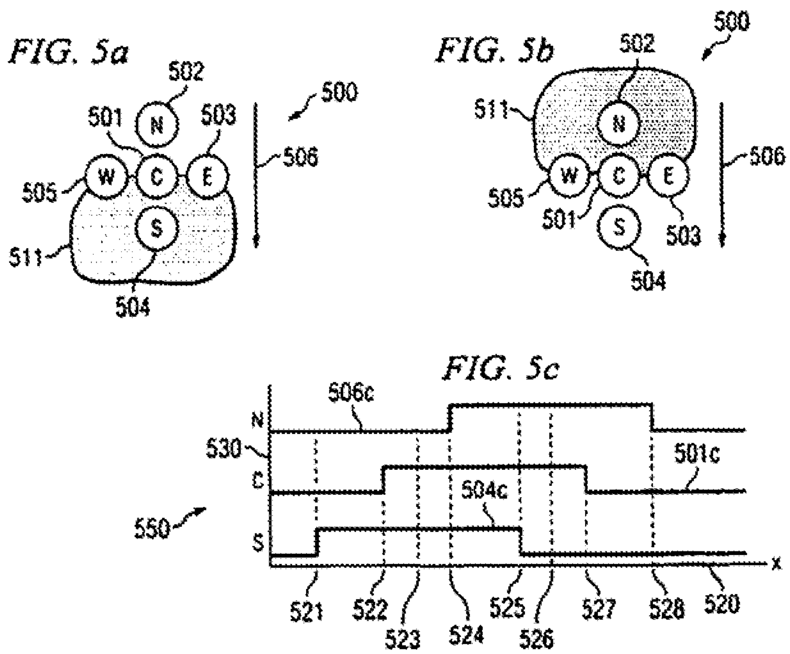


Figs. 7, 4a, 4b and 4c of the Present Patent Application

Figs. 4a, 4b, and 4c relate to example sensor cluster 400 as it interacts with speckle 411. In Fig. 4a sensor cluster 400 has moved one-quarter of the way over speckle 411. Fig. 4b depicts sensor cluster 400 having moved three-quarters of the way through speckle 411. Fig. 4c is a graphical depiction of signals 401c, 403c, and 405c of sensors 401, 403, and 405 as they move through the entire range of motion depicted in Figs. 4a and 4b. As sensor cluster 400 moves in direction 406, east sensor 403 is the first to detect speckle 411. In the graph of Fig. 4c, sensor 403's detection of speckle 411 is represented in signal 403c by signal rise 421. As sensor cluster 400 moves farther through motion 406, speckle 411 will be detected by center sensor 401. In Fig. 4c, sensor 401's detection of speckle 411 is represented in signal 401c by signal rise 422. Continuing in direction 406, sensor 405 detects speckle 411 which registers as rise 424 on signal 405c of Fig. 4c As speckle 411 passes out of range of sensor 403, signal 403c experiences signal drop 425. As cluster 400 passes further, speckle 411 will all out of range of center sensor 401 resulting in signal drop 427 of 401c. When sensor cluster 400 has passed fully over speckle 411, sensor 405 will experience signal drop 428 in signal 405c. The point in direction 406 depicted by Fig. 4a is seen on graph 450 at point 423. The point in direction 406 depicted by Fig. 4b is seen on graph 450 at point 426.

Figs. 5a, 5b, and 5c relate to the interaction of sensor cluster 500 with speckle 511 as sensor cluster 500 moves 506 across speckle 511. Fig. 5a depicts sensor cluster 500 as one-quarter of the way across speckle 511. Fig. 5b depicts sensor cluster 500 as it is moved three-quarters of the way across speckle 511. Fig. 5c graphically represents the signals 501c, 502c, and 504c generated by sensors 501,502, and 504, as they pass completely across speckle 511. As cluster 500 moves in direction 506, southern sensor 504 will be the first to detect speckle 511, as seen by rise 521 of signal 504c. At the point in direction 506 where sensor cluster 500 has moved one-quarter of the way across speckle 511, as depicted in Fig. 5a, signals 504c and 501c have registered the presence of speckle 511 through rise 521 and rise 522. As motion continues in direction 506, detector 502 will detect speckle 511 as noted

by signal rise 524. As sensor cluster 500 passes over speckle 511 and sensor 504 no longer detects speckle 511, signal 504c exhibits signal drop 525. The direction 506, as depicted in Fig. 5b, is illustrated graphically at point 526 of Fig. 5c where center sensor 501 still detects speckle 511 and northern sensor 502 also detects speckle 511. As motion in direction 506 continues, center sensor 501 will no longer detect speckle 511 resulting in signal drop 527 in signal 501c. As sensor cluster SOO passes completely over speckle 511, sensor 506 will not longer detect speckle 511 resulting in drop 528 of signal 506c.



Figs. 5a, 5b and 5c of the Present Patent Application

To determine direction of motion, various embodiments may compare the signals of certain sensors. In the embodiment depicted in Figs. 4a and 4b, direction along the horizontal axis may be determined by comparing the signals of sensors of 401,403, and 405. To determine direction, the system may link each sensor with at least one of the other sensors and compare the signals to determine a direction state. For example, when signal 403c of eastern sensor 403 experiences a rise, 403c is compared to what is occurring in signal 401c of center sensor 401. If center sensor signal 401c is low, an embodiment would not register a direction and conclude a direction state of zero. If, however, signal 401c of center sensor 401 is high, an embodiment could determine that the sensor cluster was moving from east to west. When such a direction state occurs, an embodiment could then register a horizontal direction state of -1.

In some embodiments, therefore, a sensor is designed with one-half the size of the average speckle. With this ratio, and proper spacing of the sensors, a single speckle can be detected by two adjacent sensors at the same time.
If a rise is seen in signal 401c of the center sensor 401, an embodiment could then compare this signal to both signal 403c of eastern sensor 403 and signal 405c of western sensor 405. If a rise is seen in signal 401c of center sensor 401, and signal 403c of eastern sensor 403 is high while the signal 405c of western center 405 is low, the system can determine a direction state of +1 in the horizontal, meaning that sensor cluster 400 was moving from west to east. If a rise is seen in signal 405c of western sensor 405, signal 405c can be compared to signal 401c for center sensor 401. If signal 401c for center sensor 401 is low, this direction state would then register a zero. If signal 401c for center sensor 401 is high, then this direction sate would register a +1 indicating that the sensor cluster is moving from west to east.

In similar fashion, a direction along the vertical direction may be determined by comparing signals 501c, 502c, and 504c of sensors 501,502, and 504. Again, such a method links the signal of one sensor with the signal of at least one other sensor to determine a direction state. For example, if signal 501c of center sensor 501 experiences a rise, signal 501c can be compared to

signal 504c of southern sensor 504 and signal 502c of northern sensor 502. If, at this rise in signal 501c of the center sensor 501, signal 504c of southern sensor 504 is high and signal 502c of northern sensor 502 is low, sensor cluster 500 has a vertical direction state of -1, indicating that sensor cluster 500 is moving from north to south. If when center sensor signal 501c experiences a rise, northern sensor signal 502c is high and southern sensor signal 504c is low, the vertical direction state is a +1, indicating that sensor cluster 500 is moving from south to north.

Similar to detection of direction in the horizontal direction, a rise in the signals of the outside sensors 502 and 504 may be employed to trigger a comparison with signal 501c of the center sensor 501. If at the rise of signal 502c in northern sensor 502 center sensor signal 501c is low, sensor cluster 500 has a vertical direction state of zero and no direction is indicated. If, however, at the rise in signal 502c of northern sensor 502, signal 501c of center sensor is high, sensor cluster 500 would have a vertical direction state of-1, indicating that sensor cluster 500 is moving from north to south. When a rise is seen in signal 504c of southern sensor 504, the method could again compare signal 504c to signal 501c of center sensor 501 to determine direction state. If signal 501c of center sensor 501 is low at the rise of signal 504c of southern sensor 504, sensor cluster 500 has a vertical state of zero. If, however, signal 501c of center sensor 501 is high at the rise of signal 504c of southern sensor 504, this direction state would register a+1 indicating that sensor cluster 500 is moving from south to north.

The independent claims of the present application are claims 21 and 34, which are reproduced hereinbelow as currently amended in a format showing where specific support for each element recited therein may be found in the specification and drawings as originally filed (see paragraph, page and line numbers shown in italicized square brackets set forth after each element). It should be noted that support for elements recited in claims 21 and 34, in addition to that shown below, may be found throughout the specification, drawings and abstract of the present application.

21. A method for determining a first distance along a movement path on a surface over which an optical tracking device is moved by a user *[paragraph 4, page 1, lines 1-6]*, comprising:

projecting, from a coherent light source, and along the movement path, a beam of coherent light as a first light beam incident on the surface *[paragraph 14, page 2, lines 2 and 3; paragraph 18, page 3, lines 2 and 3]*;

generating, on the surface and along the movement path, a plurality of light interference speckles resulting from the first light beam and a second light beam representing at least portions of the first light beam reflected from the surface interfering with one another *[paragraph 4, page 1, lines 1 and 2; , paragraph 14, page 2, lines 1-5]*, the speckles having at least a first average spatial dimension *[paragraph 14, page 2, lines 5-10; paragraphs 15 through 17 on page 3]*;

sensing the plurality of speckles with a plurality of light sensors arranged in a sensor cluster as the optical tracking device is moved along the movement path *[paragraph 19, page 3, lines 1-4; paragraphs 20 through 23 on pages 4 and 5]*, each of the light sensors having a second spatial dimension that is less than the first average spatial dimension of the speckles *[paragraphs 21 and 22 on page 4]*, each of the light sensors further being configured to generate a first signal when one of the plurality of speckles is disposed therebeneath and detected thereby and to generate a second signal when one of the plurality of speckles is not disposed therebeneath and not detected thereby *[Fig. 7 and paragraph 24, lines 1-6 on page 5; Figs. 4a – 4c and paragraph 25, lines 7-15 on page 5; and Figs. 5a-5c and paragraph 26, lines 4-15 on page 6]*, and

determining, on the basis of the plurality of first and second signals, the first distance *[paragraph 14, page 3, lines 12-14; paragraph 17, page 3, lines 4-6; paragraph 24, lines 7-12 on page 5]*.

34. A device for determining a first distance along a movement path on a surface over which an optical tracking device is moved by a user *[paragraph 4, page 1, lines 1-6]*, comprising:

a coherent light source configured to project a first coherent light beam along the movement path and onto the surface as an incident light beam *[paragraph 14, page 2, lines 2 and 3; paragraph 18, page 3, lines 2 and 3]*, the coherent light source being configured in respect of the surface to produce a plurality of light interference speckles resulting from the first light beam and a second light representing at least portions of the first light beam reflected form the surface interfering with one another *[paragraph 4, page 1, lines 1 and 2; , paragraph 14, page 2, lines 1-5]*, the speckles having a first average spatial dimension *[paragraph 14, page 2, lines 5-10; paragraphs 15 through 17 on page 3]*;

a plurality of light sensors arranged in a sensor cluster and operatively associated with the coherent light source and the processor *[paragraph 19, page 3, lines 1-4; paragraphs 20 through 23 on pages 4 and 5]*, each of the plurality of light sensors having a second spatial dimension that is less than the first average spatial dimension of the speckles *[paragraphs 21 and 22 on page 4]*, each of the light sensors further being configured to generate a first signal when one of the plurality of speckles is detected thereby and to generate a second signal when one of the plurality of speckles is not detected thereby *[Fig. 7 and paragraph 24, lines 1-6 on page 5; Figs. 4a – 4c and paragraph 25, lines 7-15 on page 5; and Figs. 5a-5c and paragraph 26, lines 4-15 on page 6]*, and

a processor configured to determine the first distance on the basis of the plurality of first and second signals generated by the plurality of light sensors as the device is moved over the surface *[paragraph 14, page 3, lines 12-14; paragraph 17, page 3, lines 4-6; paragraph 24, lines 7-12 on page 5; claims 8 and 9 as originally presented on page 11]*.

VI. Grounds of Rejection to Be Reviewed on Appeal

In the Final Office Action mailed August 10, 2007 the Examiner rejected claims 21-50 on the basis of 35 U.S.C. Section 103(a) as being obvious over U.S. Patent No. 4,794,384 to Jackson (hereafter "the Jackson reference) in view of U.S. Patent No. 4,751,380 to Victor (hereafter "the Victor reference"). (Note that an objection to the specification and a rejection of claims 21-33 and 50 under the first paragraph of Section 112 also included in the August 10, 2007 Final Office Action were overcome by way of amendments made to claims 21 and 34 in an Amendment after Final filed on September 7, 2007.)

The particular grounds of rejection to be reviewed on appeal are summarized as follows:

(1) Whether claims 21-50 are unpatentable under 35 U.S.C. § 103(a) as being unpatentable over the Jackson reference in view of the Victor reference.

VII. Arguments

A. The Examiner's Arguments

In regards to claims 21-50, the Examiner stated:

> Claims 21-50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jackson (US 4,794,384) in view of Victor et al (US 4,751,380 hereinafter Victor).
>
> As to claim 34, Figs. 1 and 2 of Jackson discloses a device for determining a first distance along a movement path on a surface (14) over which an optical tracking device (optical mouse 20) is moved by a user, comprising:
>
> a coherent light source (12) configured to project a first coherent light beam along the movement path and onto the surface as an incident light beam, the coherent light source (12) being configured in respect of the surface to produce a plurality of light interference speckles resulting from the first light beam and a second light representing at least portions of the first light beam reflected form the surface interfering with one another (col. 2, lines 38-44, col. 3, lines 6-12 for example), the speckles having a first average spatial dimension (col. 5, lines 15-17);
>
> a plurality of light sensors (detector array 16) operatively associated with the coherent light source and a processor (control means, Figs. 3), each of plurality of light sensors having a second spatial dimension that is less than the first average spatial dimension of the speckles (col. 4, line 62 to col. 17 for example).
>
> Jackson does not disclose the plurality of light sensor arranged in an areal pattern, each of the light sensor further being configured to generate a first signal when one of the plurality of speckles is not detected thereby, and the processor configured to determine the first distance on the basis of the plurality of first and second signals generated by the plurality of light sensors as the device is moved over the surface. However, Victor is cited to teach an optical mouse similar to Jackson. Victor teaches the optical mouse having a plurality of light sensor arranged in an areal pattern (three-by-three detector array 35 in Fig. 3), each of the light sensor (detector cells A-G) further being configured to generate a first signal (one state) when one of grid lines or spaces on the surface is detected thereby and to generate a second

signal when one of grid lines or spaces on the surface is not detected thereby (see Figs. 406, and col. 7, line 51 to col. 8, line 41 for example), and the processor (Fig. 5) configured to determine the first distance (cursor movement) on the basis of the plurality of first and second signals generated by the plurality of light sensors as the device is moved over the surface. Thus, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the optical device of Jackson to have the light sensors arranged in an areal pattern and processor as taught by Victor so as to provide a compact optical mouse due to the use of a three-by-three detector array, and the system reliably determines relative motion between the mouse and the surface (col. 8, line 55-67 of Victor).

As to claims 35, 36, Victor teaches the processor is configured to determine the direction, first distance and a first direction based on the plurality of first and second signals generated by the plurality of the light sensor as the device is moved over the surface (Figs. 4-6 of Victor).

As to claims 37, 38, Jackson teaches the processor is configured to determine at least one characteristic of the speckles (col. 4, line 63 to col. 5, line 38).

As to claim 39, Fig. 2 of Jackson teaches the coherent light source and the sensors are configured such that the first average spatial dimension of the speckles is predicted with a high degree of confidence.

As to claim 40, Jack teaches the average speckle dimension is given approximately by the equation (col. 5, lines 1-17).

As to claim 41, Jackson teaches counting the number of speckles along the optical path to determine the first distance (Fig. 4, col. 8, line 58 to col. 9, line 21).

As to claim 42, Jackson as modified by Victor does not disclose the first average speckle dimension of the speckles is selected from the group consisting of about 10 microns and ranging between about 50 and about 100 microns, or is approximately. However, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Jackson as modified by Victor to have the first average speckle dimension as claimed, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

As to claim 43, Victor teaches the plurality of light sensors comprises at least five light sensors.

As to claims 44, 45, Figs. 6 of Victor teaches the first signal is a high signal (one state) and the second signal is a low signal (zero state), or the first signal is a low signal (one state) and the second signal is a high signal (zero state),

As to claims 46, 47, Fig. 6 of Victor teaches to detect the leading edges and the trailing edges of the first and second signals.

As to claim 48, Jackson as modified by Victor does not disclose the first average spatial dimension of the speckles is at least twice that of the second spatial dimensional of the sensors. However, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Jackson as modified by Victor to have the first average speckle dimension as claimed, since it has been held that the discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F. 2d 272, 205 USPQ 215 (CCPA 1980).

As to claim 49, Jackson teaches the device is a mouse.

Claims 21-33, 50, which are method claims corresponding to the above apparatus claims 34-49, are rejected for the same reasons as stated above since such method "steps" are clearly read on by the corresponding "means".

The foregoing rejections made by the Examiner are responded to in detail below.

B. Subject Matter Recited in the Independent Claims

Claim 34 of the present application recites the following:

(a) A device for determining a first distance along a movement path on a surface over which an optical tracking device is moved by a user, comprising:

(b) a coherent light source configured to project a first coherent light beam along the movement path and onto the surface as an incident light beam;

(c) the coherent light source being configured in respect of the surface to produce a plurality of light interference speckles resulting from the first light beam and a second light representing at least portions of the first light beam reflected form the surface interfering with one another;

(d) the speckles having a first average spatial dimension;

(e) a plurality of light sensors arranged in a sensor cluster and operatively associated with the coherent light source and the processor;

(f) each of the plurality of light sensors having a second spatial dimension that is less than the first average spatial dimension of the speckles;

(g) each of the light sensors further being configured to generate a first signal when one of the plurality of speckles is detected thereby;

(h) and to generate a second signal when one of the plurality of speckles is not detected thereby, and

(i) a processor configured to determine the first distance on the basis of the plurality of first and second signals generated by the plurality of light sensors as the device is moved over the surface.

With a few minor exceptions, claim 21 of the present application essentially recites the same elements as claim 34, but does so in a method claim format. Accordingly, a separate element-by-element breakdown of claim 21 is not provided herein, and for the sake of simplicity and avoiding confusion the elements corresponding to claim 34 will be referred to below when discussing all the claims, including claim 21.

C. The Cited References

(1) The Jackson Reference

The first reference relied upon is U.S. Patent No. 4,794,384 to Jackson ("the Jackson reference"), which discloses "[a]n optical translator device capable of providing information indicative of the amount and direction of relative movement between the device and a surface positioned relative thereto. The device comprises a light source for providing at least partially coherent radiation and the source radiation is directed toward an area of the surface area. The reflected coherent radiation or light at the surface area undergoes optical interference due to the texture of the surface thereby forming a speckle pattern consisting of light and dark features. A detector array at the device comprises a plurality of photodetector cells and positioned in the path to receive the reflected light and to detect the light and dark features as represented by the cells in the array detecting light features in the reflected light thereby representative of a sample of the speckle pattern. ***Means is [sic] provided to compare consecutively produced samples which are indicative of the translatory information.*** A particular application of the optical translator device is a novel optical cursor control device which derives its translatory information from movement on substantially any sufficiently reflective surface. ***The output of the detector array is provided to circuit means to produce signals indicative of the amount and direction of relative cursor control device movement over the surface based upon observation of changes and movement of the speckle pattern as presented to the detector array.*** Such a device can be characterized as a "padless optical mouse" to

provide orthogonal signals to move a cursor from position to position on a display screen in response to movement of the mouse over any sufficiently reflective surface, such as a desk top." [Emphasis added.] See the Abstract of the Jackson reference, and Figs. 1, 2, 3B and 4 thereof reproduced hereinbelow.

Portions of the Jackson reference cited by the Examiner, and other pertinent portions of the Jackson reference, include the following:

> According to this invention, an optical translator device capable of providing information indicative of the amount and direction of relative movement between the device and a surface positioned relative thereto. The device comprises a light source for providing at least partially coherent radiation and the source radiation is directed toward an area of the surface area. The reflected coherent radiation or light at the surface area undergoes optical interference due to the texture of the surface thereby forming a speckle pattern consisting of light and dark features. A detector array at the device comprises a plurality of photodetector cells and positioned in the path to receive the reflected light and to detect the light and dark features as represented by the cells in the array detecting light features in the reflected light thereby representative of a sample of the speckle pattern. ***Means is [sic] provided to compare consecutively produced samples which are indicative of the translatory information.***

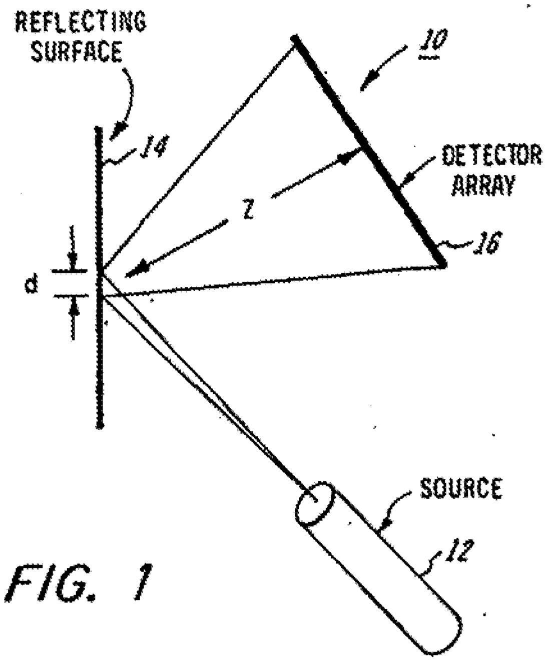


FIG. 1

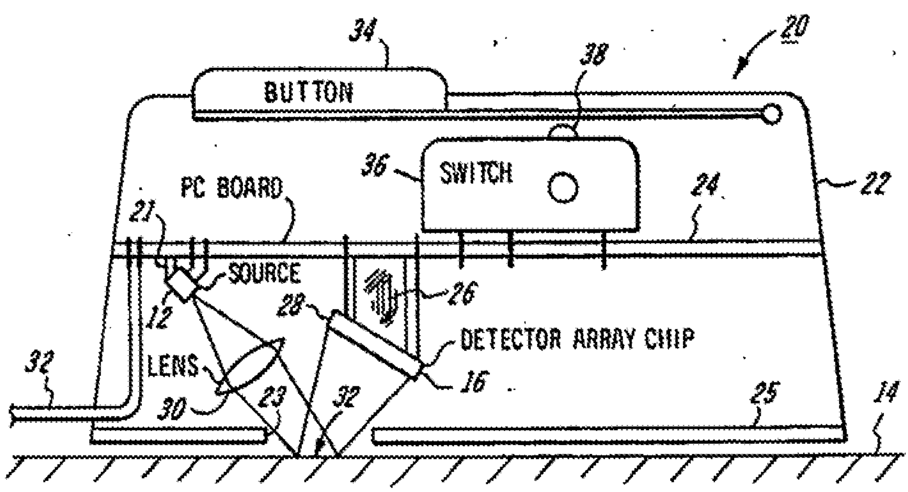


FIG. 2

Figs. 1 and 2 of the Jackson Reference

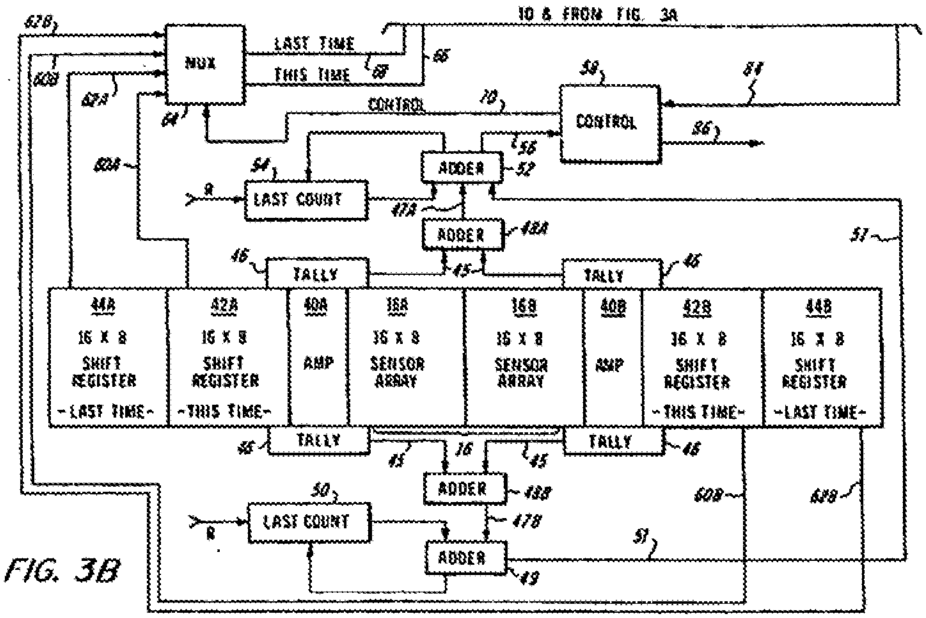


FIG. 3B

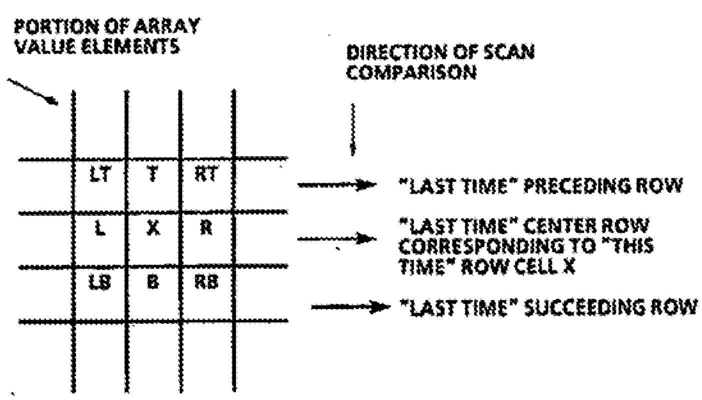


FIG. 4

Figs. 3B and 4 of the Jackson Reference

A particular application of the optical translator device is a novel optical cursor control device which derives its translatory information from movement on substantially any sufficiently reflective surface. Changes in the speckle pattern of back scattered coherent light, provided by a coherent light source in the cursor control device, reflected from such a surface is detected by an array of photodetectors. ***The output of the detector array is provided to circuit means to produce signals indicative of the amount and direction of relative cursor control device movement over the surface based upon observation of changes and movement of the speckle pattern as presented to the detector array.*** Such a device can be characterized as a "padless optical mouse" to provide orthogonal signals to move a cursor from position to position on a display screen in response to movement of the mouse over any sufficiently reflective surface, such as a desk top. Thus, special contrasting markings or special patterns are not necessary as in the case of previously known optical mice.

As previously indicated, the radiation from the source at the cursor control device is directed toward an area of the surface wherein a portion of the light is reflected from the surface area to a detector array. The reflected coherent radiation or light undergoes optical interference due to the texture or irregularity of the surface thereby forming a speckle pattern comprising light and dark features. ***The detector array comprises a plurality of photodetector elements or cells that are permitted to detect light features of the pattern within a dynamically determined period of time. The read out of the detected values from the array is a representation of a sample of the speckle pattern. Comparison of a prepared and valid sample with a previously determined valid sample provides data indicative of the amount and direction of such relative movement of the device over the surface. Comparison and movemental signal development are provided by circuit means coupled to the detector array. The circuit means also provides a determination of the number of detector cells in***

the array that have detected light features and compares these numbers with a predetermined value indicative of whether the sample is a good representation of the speckle pattern before being declared as an acceptable or valid sample. *Col. 2, line 34 through col. 3, line 29 of U.S. Patent No. 4,794,384 to Jackson.*

The relationship of the size of the speckle features and their contrast ratio relative to the size of the detector cells in the array 16 depends upon several factors including the roughness or minute irregularity of surface 14 and the extent of coherence of source 12. The speckle pattern features are larger than the size of the individual detector cells. Minimum speckle size at detector array 16 is determined by the formula:

alpha = (2 x lambda x Z)/d

where alpha is the minimum speckle size, lambda. is the wavelength of coherent light of source 12, Z is the distance from reflecting surface 14 to detector array 16 and d is the diameter of the illuminated spot at surface 14. Speckle size should be sufficiently large so as to provide a detectable speckle pattern within the framework of the dimensions of the detector array 16. Required minimum speckle feature size can be accomplished by making the size of the illuminated spot on surface 14 smaller or by making the distance Z larger. The average speckle feature size is generally a little larger than this minimum value.

The contrast ratio is an indication of the contrast between light and dark speckle features which is important since the job of the detector array 16 is detecting moving edges created between these two types of features. The contrast ratio is determined by:

$$C = (I_{max} - I_{min})/(I_{max} + I_{min})$$

where C is the contrast ratio, Imax is the maximum intensity at the array and Imin is the minimum intensity at the array.

The contrast ratio will vary according to the coherency of source 12 and the irregularity features of surface 14. The more coherent the source 12, the higher the contrast.

In practice, the surface 14 most likely will be a desk surface which will produce a good speckle pattern. By monitoring the amount of light reflected from surface 14, different levels of reflected intensity can be compensated for at the detector array. *Col. 4, line 63 through col. 5, line 38 of U.S. Patent No. 4,794,384 to Jackson.*

In use, the mouse 20 is moved over surface 14. The light source 12 in mouse 20 illuminates a portion 32 of surface 14 as the mouse is moved over its surface. The light and dark features of the reflected speckle pattern illuminate the surface of detector array 16. ***As the mouse 20 is moved across surface 14, the speckle pattern, characteristic of source 12, moves with it. By making an intensity trace across the speckle pattern with the detector array 16 and correlating it with a trace taken just prior thereto, the relative motion between the two traces can be determined as well as the direction of its movement.***

Two linear arrays of detectors on a single chip may be used or a two dimensional array on a single chip may be used. Examples of detector arrays are charge couple devices (CCD) or a plurality of silicon photodetector cells.

An important aspect is the width of the sample window for the detector array. The sample time must be constant for repeated samples of a speckle intensity pattern having substantially the same contrast ratio in order to provide useful information relative to motion and direction. It is important the time of sample be adjustable. If the time of sample is not adjustable, then the cursor control will be constrained to operate only with reflecting surfaces that provide sufficient photon flux to affect the detector cells during the sample window. However, the sample window must not be so long as to saturate all the detector cells. Therefore, for the detector array to work effectively with surfaces of widely varying reflectivity levels, the sample window of the array must be adjustable to compensate for differences in surface reflectivity levels.

Since the speckle pattern being sampled can, in a sense, be thought as composed of equal mixtures of light and dark features, the sample window can be determined complete when the accumulated photocurrent for half of the detector cells have exceeded a predetermined threshold. ***This dynamically determined threshold technique will provide a fairly constant sampling window which will automatically change when the reflectivity of the surface being observed changes.***

FIGS. 3A and 3B discloses [sic] circuit means for carrying out the sample window strategy and motion determination of this invention. For FIG. 3B, detector array 16 is a sixteen by sixteen square array of 256 detector cells. The time to take a total sample must be as short as possible in order to have a practical sampling rate useful for motion detection as a cursor control device. If the sampling window is short in time compared to the time it takes light to discharge the charge present on the nodes of the detector cells, then the total sample acquired during the sample window will be a reasonable representation of the speckle pattern incident on the detector cells. *Col. 5, line 64 through col. 6, line 51 of U.S. Patent No. 4,794,384 to Jackson*

The grand total value is compared to the binary number 128 representing one half of the detector cells of array 16. This value may be chosen to more or less than half the number of cells in the array. The idea is to obtain a sufficient representation of distinguishable features from the instantaneous speckle pattern that will be useful as a representation of that pattern for comparison with later determined valid sampled patterns. In any case, if the grand total value is equal to or greater than the binary value of 128, then the current sample is deemed valid and is indicated as such by high or "1" on line 56 from adder 52 to control circuit 58 and the values in the array sampled may then be shifted out in parallel groups of sixteen bit values into shift registers 42A and 42B. On the other hand, if the number is less than the binary value of 128, then this particular tallied sample is discarded and another tally is taken from array 16 of the pattern received from the reflecting surface 14.

If a tallied sample is determined to be valid sample in this manner and is shifted out in rows of sixteen parallel cell values with half to shift register 42A and the other half to shift register 42B, the content of values for a previously determined valid sample still present in shift registers 42A and 42B are respectively shifted out in rows of sixteen parallel cell values into shift registers 44A and 44B. In this manner, the values in shift registers 42A and 42B represent the most recent or instant valid sample, termed THIS TIME, and the values in shift registers 44A and 44B represent the immediately past or last valid sample, termed LAST TIME.

Thus, the amplified values or bits are then shifted out in 16 parallel values to 16 by 8 THIS TIME shift registers 42A and 42B until all sixteen cell lines of each subarrays 16A and 16B have been readout and their values stored in THIS TIME registers 42A and 42B. By the same token, the values for a previous valid sample, present in THIS TIME registers 42A and 42B, are shifted out of these registers in parallel into 16 by 8 LAST TIME shift registers 44A and 44B. The sequential shifting of sixteen parallel bit values from subarrays 16A and 16B as well as from THIS TIME registers 42A and 42B to LAST TIME shift registers 44A and 44B is accomplished simultaneously in eight clock periods.

With valid samples achieved, a determination can now be made as to the relative differences or changes between the detected THIS TIME pattern as compared to the detected LAST TIME pattern. The correlation of THIS TIME and LAST TIME data is accomplished by the circuit complex 72 shown in FIG. 3B. The rows of sixteen parallel cell values in registers 42A, 42B and 44A, 44B are sequentially provided, in serial fashion, on lines 60A, 60B, 62A and 62B to multiplexer 64 wherein the values for rows of 16 parallel bits from THIS TIME shift registers 42A and 42B and comparable rows of 16 parallel bits from LAST TIME shift registers 44A and 44B are multiplexed to produce sequentially sixteen serial bit line values respectively for THIS TIME data and LAST TIME data. This data is clocked from multiplexer 64 respectively along THIS TIME line 66 and LAST TIME line 68. The control signals to operate multiplexer 64 are received along control bus 70 from control 58. The main task of control signals on bus 70 is to switch input line pairs 60A and 62A; 60B and 62B to multiplexer 64 from one set of lines to another for bitwise correlation by circuit 72 in a manner as next explained below.

Bitwise autocorrelation embraces the concept of comparing a given bit value for each of the 256 cells in the array with the bit value of neighboring cells surrounding the given cell to determine how many such comparisons are the same and then a count is kept of the number of such comparisons for different groups of identical cell pair comparison.

As illustrated in FIG. 4, there are eight surrounding neighbors for each given cell X, not counting edge cells of the array. These positions are top (T), left top (LT), left (L), left bottom (LB), bottom (B), right bottom (RB), right (R) and right top (RT). ***For each cell in the array, a comparison for identical values is made relative to each of those eight adjacent cell positions and the tally of those eight comparisons for each cell position in the array is maintained in a respective counter until the process is complete for an entire sample comparison. This requires eight counters for each of the eight cell pair comparisons to be accomplished. Upon sample completion, the highest value in any one of the eight counters is subtracted from the next highest count value in any one of the eight counters. If the difference is more than a predetermined threshold, then the counter with the highest count is a valid indication of pattern movement with the direction of movement being represented by the counter with the highest number. However, if the highest number and the next highest number in such a sample comparison are the same or are below the predetermined threshold, this is a valid indication of no pattern movement.*** For example, in FIG. 4, if the count for RT comparisons with X throughout the array is higher than any other such comparison count and the difference between its value and the second highest of such count comparisons for all cells throughout the array exceeds a predetermined threshold, then a valid determination has been made that movement from a LAST TIME pattern to a THIS TIME pattern has been in the direction of X.fwdarw.RT, i.e., in a compassable direction described as from southwest to northeast.

The above described system is, therefore, based upon a preponderance of "votes" determining a direction of movement. ***The system utilizes the concept of comparing neighboring values from a previous sample with each array cell value in a new sample to determine if they are the same. If any of the eight comparisons provide an indication of being the same, whether a dark feature or a light feature, then there is a possibility that the pattern feature being detected has "moved" to new cell position.*** An identical cell pair value counts as one point and the appropriate counter representing that pair comparison is incremented. It can be seen, then, that if the preponderance is that a certain majority of light features detected in the speckle pattern presented to the array have moved in a given direction and also a certain majority of dark features have moved in the same given direction, a reliable indication has been derived that the relative motion between the array 16 and the reflecting surface 14 is in the given direction.

The reliability of this correlation method is based upon not only the preponderance of the "votes" but also due to (1) a cancelling effect which is obtained when the total count for equal and opposite comparisons are the same, or nearly the same, so that no weight can be given for movement in that direction, and (2) an elimination of the effect of the disappearance or diminishing of intensity features in the speckle pattern and their subsequent return which is accomplished by comparing the difference between the highest count value obtained upon complete sample comparison which is subtracted from the next highest count value obtained from the sample comparison and determining that the difference is above a predetermined threshold. The threshold value is a number value which is a measure of the confidence that the pattern has moved in the direction indicated by the counter having the highest indicated value.

> This value may be sufficiently high to provide a reliable level of confidence regardless of the system "noise" due, for example, to thermal and analog processes. *Col. 7, line 53 through col. 9, line 61 of U.S. Patent No. 4,794,384 to Jackson*

Reference to the above-cited portions and figures of the Jackson reference shows that Jackson discloses a rather elaborate and computationally intensive optical mouse tracking system relies upon the acquisition and subsequent processing of large amounts of data from large areal arrays of photosensors as a mouse is moved over a surface and light speckles are generated thereon. These large arrays of photosensors send signals representative of the amount of light being sensed by each of the various photosensors in the array at a given moment in time. The array values corresponding to that snapshot in time are stored in a shift register for comparison to array values corresponding to an earlier or later snapshot in time. Patterns present in the respective arrays are determined using computationally intensive two-dimensional autocorrelation techniques, and then compared to one another to determine the direction and amount of movement that has occurred in respect of the two snapshots in time.

Nowhere does the Jackson reference disclose, discuss, hint at or suggest sensing the rising and falling edges of light speckles using relatively small areal arrays of photosensors or photodetectors, and then, in a processor, comparing such rising and falling edges, and the high and low states that lie between such rising and falling edges, as a means of determining direction and magnitude of movement of a mouse over a surface. The computational techniques employed in the presently-claimed invention are far less computationally intensive than those required by the navigation processing techniques described in the Jackson reference. In the present invention, only simple comparisons of a limited number of voltages or values to one another are required top measure direction and distance. In contrast, Jackson requires extensive number-crunching using sophisticated two-dimensional autocorrelation techniques. Moreover, the computational techniques described in Jackson require the use of much larger arrays of sensors than those required in the presently-claimed invention.

Reference to claims 21-50 as currently pending will show that those claims contain limitations disclosed nowhere in the cited Jackson reference. More particularly, reference to claims 21-50 shows that Jackson discloses none of, nor hints at or suggests any of, elements (d), (f), (g), (h) or (i), or their similar method equivalents, as they are recited in claims 21-50 and as they are set forth above in Section VII (B) hereinabove. In other words, at least five separate and interconnected elements recited in claims 21-50 are nowhere to be found in the Jackson reference. Thus, it will now be seen that many elements and limitations recited in all the pending claims are disclosed and taught nowhere, and suggested nowhere, in the cited Jackson reference.

Moreover, review of the Jackson reference discloses that Jackson reveals no awareness of some of the problems solved by the present invention, such as overcoming the difficulties associated with employing large sensor arrays, using computationally intensive autocorrelation, pattern recognition or pattern comparison data processing techniques, or requiring that a specific optical grid pattern be employed beneath a mouse to permit computer navigation by a user.

(2) The Victor Reference

The second reference relied upon is U.S. Patent No. 4,751,380 to Victor et al. ("the Victor reference"), which discloses "[a] cursor position control system in which an optical mouse having a light source and three-by-three detector array moves over a surface having a grid pattern or intersecting orthogonal grid lines of a first color and spaces defined between the grid lines of a second contrasting color. The grid lines are characterized by a line width. Detector cells are grouped into pairs of cells for detecting motion in a particular direction. Cells in a pair are separated so as to image areas an odd multiple of line widths apart in a direction orthogonal to that particular direction. Pairs of cells image areas separated in the particular direction from areas imaged by related pairs of cells by an odd multiple of half line widths. Pairs of electrical signals from pairs of cells are combined then differentiated with respect to time to produce related quadrature signals indicative of the amount and direction of movement of the mouse relative to the surface." See the Abstract and Figs. 3-6 of the Victor reference reproduced hereinbelow.

Portions of the Victor reference cited by the Examiner, and other pertinent portions of the Victor reference, include the following:

The above object has been met with a cursor position control system in which an optical mouse movable over a grid surface has a detector which is a three-by-three array of detector cells. The surface has a grid pattern thereon which is made up of two intersecting orthogonal sets of parallel grid lines and spaces defined between the grid lines. The grid lines are of a first color and the spaces are of a second contrasting color. The grid lines are uniformly spaced apart and of a uniform line width. The spaces have a width which is equal to the line width. The mouse has a light source which illuminates a portion of the surface and the detector is disposed to receive and detect the light reflected from the surface.

The detector cells image areas of the grid pattern which typically have a characteristic dimension which is substantially equal to one-half of the line width. Seven of the nine detector cells are used. The cells are grouped into pairs of cells which are located so as to image areas on the grid pattern a distance of an odd multiple of line widths apart in a direction which is orthogonal to the direction of motion which they detect. Thus, for example, a pair of cells for detecting vertical motion may be located for imaging areas one line width horizontally apart, thereby ensuring that one of the cells in the pair detects crossings of the mouse through spaces and horizontal grid lines. Alternatively, a pair of cells for detecting vertical motion may be located for imaging areas on the grid which are spaced three, five, seven or some other odd number of line widths horizontally apart. Similarly, pairs of cells for detecting horizontal motion may be located for imaging areas one, three or other odd number of line widths vertically apart. There are two pairs of cells for detecting horizontal motion and two pairs of cells for detecting vertical motion. One pair of cells for detecting a particular direction of motion image areas that are located one-half line width, three-halves line widths or other odd multiple of half line widths apart in that direction of motion from the areas imaged by other related pair of cells, thereby producing a distinguishable lead or lag in the detection by the pairs of cells of crossings over spaces and grid lines.

> The detector cells produce an electrical output signal corresponding to the amount of light they receive. The signals from each of the four pairs of cells are combined and then converted to four quadrature signals of square waves. The quadrature signals switch to a first state when the combined signals are increasing with time and switch to the opposite state when the combined signals are decreasing with time, or vice versa, thereby avoiding threshold problems and the need for a reference voltage. *Col. 2, lines 20-57, U.S. Patent No. 4,751,380 to Victor.*

As described above, and as further described in the Abstract of the Victor reference, Victor discloses a cursor position control system in which some sensors are dedicated to sensing horizontal lines, and other sensors are dedicated to sensing vertical lines. Still other sensors sense neither vertical nor horizontal lines. In any case, it is a requirement of the system disclosed by Victor that the surface over which the cursor position control system moves have a grid of high contrast vertical and horizontal lines printed or otherwise disposed thereon, wherein the grid lines may be easily optically distinguished from the background of the surface upon which they are disposed. The Victor reference discloses projecting light from source 15, the projected light being reflected from grid pattern 18 for sensing by detectors 25, which in turn provide output signals on the basis of which movement may be calculated.

By way of further example, Victor states:

> In FIG. 1, a partial grid pattern 16 may be seen on surface 13, with dark orthogonal lines and white spaces between lines. Surface 13 has a horizontal and vertical repetitive pattern of passive, position related indicia which extends over at least a portion of the surface. Preferably, these indicia are marks of high optical contrast, such as an optically absorptive and reflective pattern. Such a pattern could be a shiny metallic, white or other highly reflective surface with a grid of black lines marked on the surface. The lines are printed with ink having pigment particles with the desired optical property. Alternatively, black squares may be marked on the surface, resulting in the pattern 18 seen in FIG. 1a having reflective grid lines with low reflectivity spaces therebetween. The grid pattern is discussed further below in greater detail with reference to FIG. 4.
>
> The cursor position control system of the present invention, which comprises optical mouse 11 and surface 13 with grid pattern 16, generates electrical signals which instruct a cursor regarding movement up or down, left or right. There is no particular starting place for the mouse on the surface and it may be brought down any place on the surface, so long as there is sufficient room to move the mouse in a direction wherein cursor motion is desired. When placing the mouse on the surface, alignment should be such that detector 25 is appropriately oriented with respect to the grid pattern on the surface, as shown in FIG. 4.

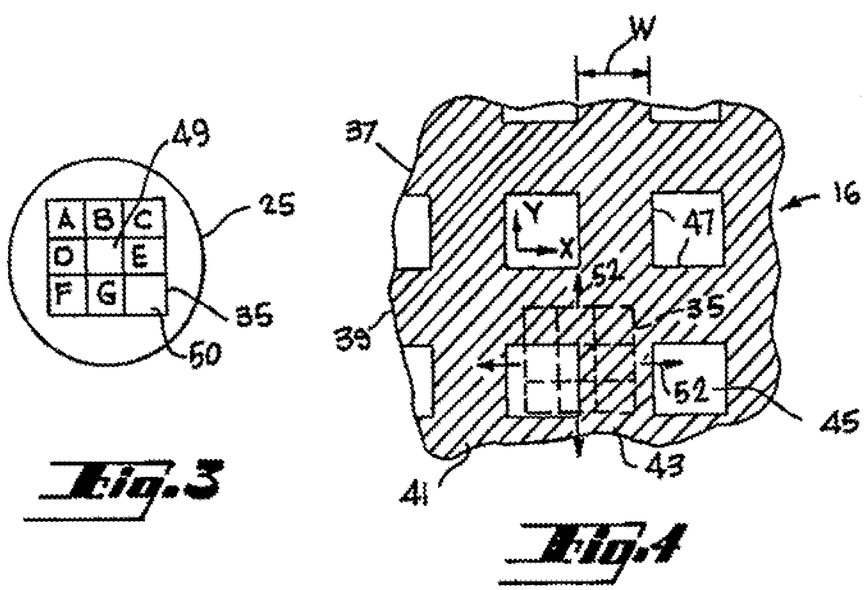
Nowhere does the Victor reference disclose, discuss, hint at or suggest generating light interference patterns with source 15 or detecting light interference patterns with detector 25. Nowhere does the Victor reference disclose, discuss, hint at or suggest generating interference speckles on a surface using a coherent light source for subsequent detection by a plurality of light sensors operatively associated with the coherent light source.

Instead, Victor discloses sensing areas of grid pattern 18 having high and low light reflectivity that correspond to grid lines and the spaces between grid lines, respectively. See the entirety of the Victor reference.

Nowhere does the Victor reference disclose generating, on surface 13 and along a movement path, a plurality of light interference speckles as a result of the first light beam and a second light beam representing at least portions of the first light beam reflected from the surface interfering with one another. Nowhere does the Victor reference disclose sensing the plurality of speckles with a plurality of light sensors as the optical tracking device is moved along a movement path. Nowhere does the Victor reference disclose determining, on the basis of the sensed speckles, a distance mouse 11 or other device moves over surface 13.

Reference to claims 21-50 as currently pending will show that those claims contain limitations disclosed nowhere in the cited Victor reference. Referring to the Victor reference and the portions thereof set forth above, it becomes clear that Victor et al. disclose none of, nor hint at or suggest any of, elements (c), (d). (f), (g), (h) or (i), or their similar method equivalents, as they are recited in claims 21-50 and as they are set forth above in Section VII (B) hereinabove. In other words, at least six separate and interconnected elements recited in claims 21-50 are nowhere to be found in the Victor reference. Thus, it will now be seen that many elements and limitations recited in all the pending claims are disclosed and taught nowhere, and suggested nowhere, in the cited Victor reference.

Moreover, review of the Victor reference discloses that Victor reveals no awareness of some of the problems solved by the present invention, such as overcoming the difficulties associated with employing large sensor arrays, using computationally intensive autocorrelation, pattern recognition or pattern comparison data processing techniques, or requiring that a specific optical grid pattern be employed beneath a mouse to permit computer navigation by a user.



Figs. 3 and 4 of the Victor Reference

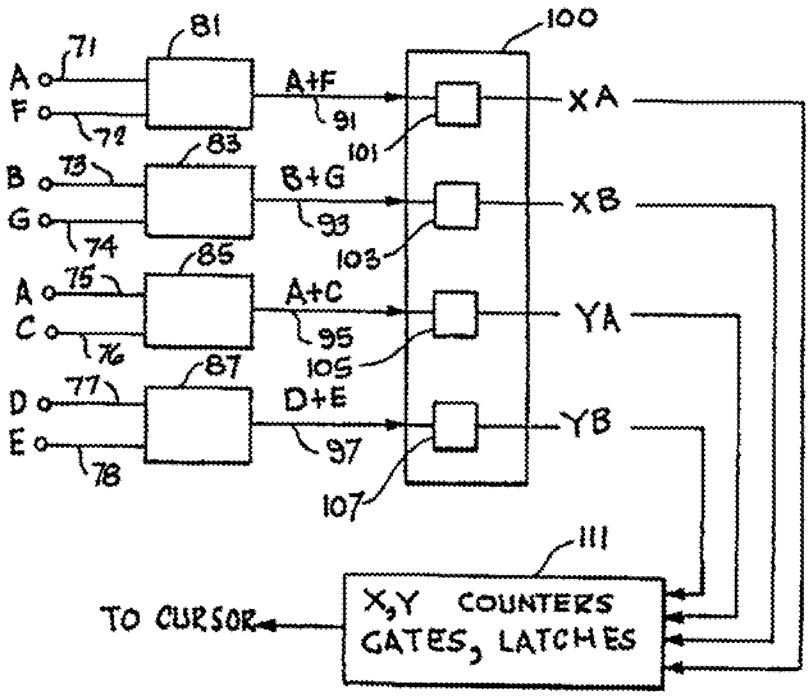


Fig.5

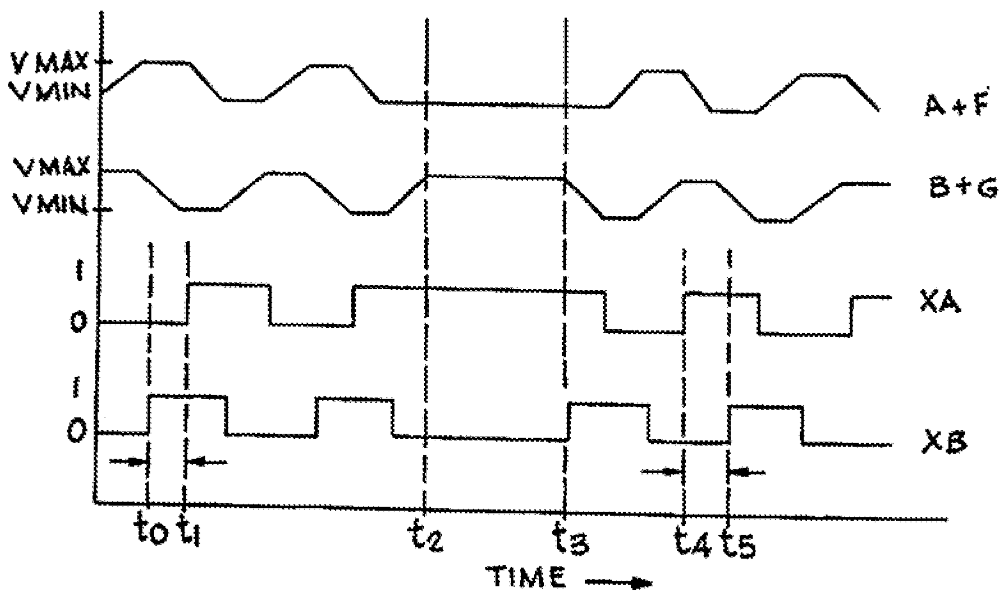


Fig.6

Figs. 5 and 6 of the Victor Reference

D. Applicant's Arguments

(1) Claims 21-50 are not obvious over the Jackson Reference in view of the Victor reference

As discussed in detail above in the section describing the content of the Jackson reference, the Jackson reference discloses none of, nor hints at or suggests any of, elements (d), (f), (g), (h) or (i), recited in claims 21-50 as those elements are set forth in Section VII (B) hereinabove. In other words, at least five separate and interconnected elements recited in claims 21-50 are nowhere to be found in the Jackson reference.

Also as discussed in detail above in the section describing the content of the Victor reference, the Victor reference discloses none of, nor hints at or suggests any of, elements (c), (d). (f), (g), (h) or (i), recited in claims 21-50 as those elements are set forth in Section VII (B) hereinabove. In other words, at least six separate and interconnected elements recited in claims 21-50 are nowhere to be found in the Jackson reference.

Thus, there is no possible combination of elements from the Jackson and Victor references that could yield any one or more of elements (d), (f), (g), (h) and (i) missing from both references. Thus, it will now be seen that at least five separate elements and limitations recited in all the pending claims are disclosed and taught nowhere, and suggested nowhere, in the cited Jackson and Victor references.

Neither the Jackson reference nor the Victor reference discloses speckles having a first average spatial dimension.

Neither the Jackson reference nor the Victor reference discloses each of a plurality of light sensors having a second spatial dimension that is less than the first average spatial dimension of the speckles.

Neither the Jackson reference nor the Victor reference discloses each of a plurality of light sensors being configured to generate a first signal when one of a plurality of speckles is detected thereby.

Neither the Jackson reference nor the Victor reference discloses generating a second signal when one of a plurality of speckles is not detected thereby.

Neither the Jackson reference nor the Victor reference discloses a processor configured to determine a first distance on the basis of a plurality of first and second signals generated by a plurality of light sensors as a device (*e.g.*, a mouse) is moved over the surface.

The Jackson reference, as discussed in detail above, discloses a rather elaborate and computationally intensive optical mouse tracking system relies upon the acquisition and subsequent processing of large amounts of data from large areal arrays of photosensors as a mouse is moved over a surface and light speckles are generated thereon. These large arrays of photosensors send signals representative of the amount of light being sensed by each of the various photosensors in the array at a given moment in time. The array values corresponding to that snapshot in time are stored in a shift register for comparison to array values corresponding to an earlier or later snapshot in time. Patterns present in the respective arrays are determined using computationally intensive two-dimensional autocorrelation techniques, and then compared to one another to determine the direction and amount of movement that has occurred in respect of the two snapshots in time.

The Victor reference, as discussed in detail above, discloses a cursor position control system in which some sensors are dedicated to sensing horizontal lines, and other sensors are dedicated to sensing vertical lines. Still other sensors sense neither vertical nor horizontal lines. In any case, it is a requirement of the system disclosed by Victor that the surface over which the cursor position control system moves have a grid of high contrast vertical and horizontal lines printed or

otherwise disposed thereon, wherein the grid lines may be easily optically distinguished from the background of the surface upon which they are disposed.

The Applicants have discovered that a certain novel combination of interconnected electronic, optical and computing elements and steps combined in a certain order and arranged in a certain manner are required to produce the beneficial effects of the present invention. As shown above, at least five of those interconnected elements and arrangements are neither disclosed nor suggested anywhere in the Jackson or Victor references, and accordingly cannot be *prima facie* obvious.

Merely asserting that "would be obvious to try" the invention by making reference to the highly computationally-intensive two-dimensional digital filtering array navigation scheme of Jackson, and the gridded line array optical detection scheme of the Victor reference, while essentially creating other claimed elements out of whole cloth without referring to any specific portions of the cited references to establish a motivation for combining elements or functionality disclosed therein, does not establish a *prima facie* case of obviousness.

There is no incentive, teaching or suggestion in the Jackson or Victor references to produce the invention now recited in claims 21-50. The mere fact that the cited Jackson and Victor references could, with the benefit of hindsight, produce something vaguely similar to the present invention does not make the modification obvious, or suggest the desirability of the modification required to arrive at the present invention. Indeed, this conclusion is buttressed by the fact that numerous elements and limitations are missing in Jackson and Victor references in respect of claims 21-50.

It is well settled that a motivation to combine elements or limitations disclosed in disparate references *must be found within the references themselves or from pertinent sources of extrinsic information,* and that such a motivation does not arise, as here, by merely identifying a collection of disparate piece parts in different references, and then asserting it would have been obvious to take such disparate elements and limitations and add many others thereto to arrive at the presently claimed invention.

In such a context, and as pointed out above, it is particularly noteworthy that the cited Jackson and Victor references ***disclose nothing concerning some of the problems solved by the present invention***, such as how to overcome the difficulties associated with employing large sensor arrays, using computationally intensive autocorrelation, pattern recognition, and pattern comparison data processing techniques, or requiring that a specific optical grid pattern be employed beneath a mouse to permit computer navigation by a user.

There is no suggestion of what direction any experimentation should follow in the Jackson and Victor references to obtain the invention recited in claims 21-50. Accordingly, the result effective variables, for example providing speckles on a navigation surface having a first average spatial dimension followed by providing in a navigation device such as a mouse a plurality of light sensors having a second spatial dimension that is less than the first average spatial dimension of the speckles, are not known to be result effective. Thousands or millions of attempts at variations might be made before arriving at the desired improvement. Thus, to say that it is obvious to read the Jackson and Victor references and somehow arrive at the invention now recited in claims 21-50 is clearly not the test for obviousness, and moreover completely misses the point that so many elements and limitations required by the presently pending claims are missing from the cited references.

The foregoing analysis also makes it clear that there is no basis in the art for modifying the teachings of the Jackson and Victor references to arrive at the invention now recited in claims 21-50. Obviousness cannot be established by combining or modifying the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. As pointed out in detail above, the Jackson and Victor references do not teach the problems associated with, or the sources of such problems, respecting how to deal with the difficulties associated with employing large sensor arrays, using computationally intensive autocorrelation, pattern recognition, and pattern comparison data processing techniques, or requiring that a specific optical grid pattern be employed beneath a mouse to permit computer navigation by a user.

When, as here, the prior art itself provides no apparent reason for one of ordinary skill in the art to make a modification or to combine references, an argument clearly does not exist that the claimed subject matter would have been obvious. Thus, using the applicants' own disclosure as a blueprint to reconstruct in hindsight the invention recited in claims 21-50 out of isolated teachings appearing in the prior art is clearly improper.

The results and advantages produced by the invention set forth in claims 21-50, and of which the Jackson and Victor references are utterly devoid, cannot be ignored simply because the claim limitations might be deemed similar to the otherwise barren prior art.

The foregoing analysis further makes it clear that many limitations appearing in claims 21-50 are simply not present in the Antila and University of Michigan-Dearborn references. When evaluating a claim for determining obviousness, ***all limitations of the claim must be evaluated.*** Under §103, claims 21-50 cannot be dissected in turn, the various individual elements recited in the claims excised, and then the remaining portions of the mutilated claims declared to be unpatentable. The basic rule of claim interpretation of reading the claims as a whole must be followed. Accordingly, the Jackson and Victor references may not properly be used as a basis for rejecting claims 21-50 under §103(a).

The functions, ways and results provided by the devices and methods disclosed in the Jackson and Victor references are completely different from those provided by the presently claimed invention. The navigation system of Jackson functions by sensing multiple channels of sensor array data, storing such data in a memory or buffer, and then engaging in complex and lengthy autocorrelation computations to determine navigation device direction and distance. The Victor reference employs a relatively simple system for navigation, where a predetermined array of regularly spaced and optically distinct lines are arranged on a navigation surface disposed beneath a navigation device.

In respect of the basic problems solved by the present invention, the results provided by the Jackson and Victor references are identical: the structures and methods disclosed in both references, or the structures that might somehow be produced by combining the elements disclosed in both references, are ***totally incapable of providing any solutions to the problems of accurately and reliably detecting speckles on a navigation surface, and on that basis determining navigation device distance and direction, without resorting to highly complex and intensive two-dimensional digital filtering techniques.***

Finally, there is no combination of disparate elements from the Jackson and Victor references that could possibly result in the present invention. Instead, and in a light most favorable to the mythical person of ordinary skill in the art, combining elements from those two references would result in a navigation device where two-dimensional digital filtering techniques are employed to compute distance and direction travelled by the navigation device over an underlying array of grid lines arranged at right angles in respect of one another.

For all the foregoing reasons and more, the presently claimed invention is not *prima facie* obvious in view of the Jackson over the Victor references, alone or in combination.

VIII. Summary

Claims 21-50 are the subject of this Appeal, and are believed to be in condition for allowance. Review and allowance of the appealed claims as presented herein is requested. The Board is respectfully requested to contact the undersigned by telephone or e-mail with any questions or comments they may have.

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Claims Appendix

21. A method for determining a first distance along a movement path on a surface over which an optical tracking device is moved by a user, comprising:

projecting, from a coherent light source, and along the movement path, a beam of coherent light as a first light beam incident on the surface;

generating, on the surface and along the movement path, a plurality of light interference speckles resulting from the first light beam and a second light beam representing at least portions of the first light beam reflected from the surface interfering with one another, the speckles having at least a first average spatial dimension;

sensing the plurality of speckles with a plurality of light sensors arranged in a sensor cluster as the optical tracking device is moved along the movement path, each of the light sensors having a second spatial dimension that is less than the first average spatial dimension of the speckles, each of the light sensors further being configured to generate a first signal when one of the plurality of speckles is disposed therebeneath and detected thereby and to generate a second signal when one of the plurality of speckles is not disposed therebeneath and not detected thereby, and

determining, on the basis of the plurality of first and second signals, the first distance.

22. The method of claim 21, further comprising determining, on the basis of the first and second signals generated by the plurality of light sensors as the device is moved over the surface , a direction in which the optical tracking device moves along the movement path.

23. The method of claim 21, further comprising comparing the plurality of first and second signals to determine the first distance.

24. The method of claim 21, further comprising comparing the plurality of first and second signals to determine a direction in which the optical tracking device moves along the movement path.

25. The method of claim 21, further comprising sensing at least one characteristic of the speckles.

26. The method of claim 25, wherein the at least one characteristic is selected from the group consisting of speckle length, speckle width, speckle dimension, an edge of a speckle, a distance between speckles, a distance between leading edges of speckles, and a distance between trailing edges of speckles.

27. The method of claim 21, further comprising configuring the coherent light source and the plurality of light sensors such that the first average spatial dimension of the speckles may be predicted with a high degree of confidence.

28. The method of claim 21, further comprising configuring the coherent light source and the plurality of light sensors such that the first average spatial dimension of the speckles is given approximately by the equation:

$$\lambda \cdot (R/d),$$

where λ is a wavelength of the light emitted by the coherent light source, R is a second distance the coherent light source is from the surface, and d is a diameter of the coherent light beam.

29. The method of claim 21, further comprising counting the number of speckles along the optical path to determine the first distance.

30. The method of claim 21, wherein the first average spatial dimension of the speckles is selected form the group consisting of about 10 microns and ranging between about 50 microns and about 100 microns.

31. The method of claim 21, wherein the plurality of light sensors comprises at least five light sensors.

32. The method of claim 21, wherein the first signal is a high signal and the second signal is a low signal.

33. The method of claim 21, wherein the second signal is a high signal and the first signal is a low signal.

34. A device for determining a first distance along a movement path on a surface over which an optical tracking device is moved by a user, comprising:

a coherent light source configured to project a first coherent light beam along the movement path and onto the surface as an incident light beam, the coherent light source being configured in respect of the surface to produce a plurality of light interference speckles resulting from the first light beam and a second light representing at least portions of the first light beam reflected form the surface interfering with one another, the speckles having a first average spatial dimension;

a plurality of light sensors arranged in a sensor cluster and operatively associated with the coherent light source and the processor, each of the plurality of light sensors having a second spatial dimension that is less than the first average spatial dimension of the speckles, each of the light sensors further being configured to generate a first signal when

one of the plurality of speckles is detected thereby and to generate a second signal when one of the plurality of speckles is not detected thereby, and

a processor configured to determine the first distance on the basis of the plurality of first and second signals generated by the plurality of light sensors as the device is moved over the surface.

35. The device of claim 34, wherein the processor is further configured to determine, on the basis of the plurality of first and second signals generated by the plurality of light sensors as the device is moved over the surface, a direction in which the optical tracking device moves along the movement path.

36. The device of claim 34, wherein the processor is further configured to compare the plurality of first and second output signals to determine at least one of the first distance and a first direction.

37. The device of claim 34, wherein the processor is further configured to determine at least one characteristic of the speckles.

38. The device of claim 37, wherein the at least one characteristic is selected from the group consisting of speckle length, speckle width, speckle dimensions, an edge of a speckle, distance between speckles, distance between leading edges of speckles, and distance between trailing edges of speckles.

39. The device of claim 34, wherein the coherent light source and the plurality of sensors are configured such that the first average spatial dimension of the speckles may be predicted with a high degree of confidence.

40. The device of claim 34, wherein the coherent light source and the plurality of sensors are configured such that the first average speckle dimension is given approximately by the equation:

$$\lambda \cdot (R/d),$$

where λ is a wavelength of the light emitted by the coherent light source, R is a second distance the coherent light source is from the surface, and d is a diameter of the coherent light beam.

41. The device of claim 34, wherein the processor is further configured to count the number of speckles along the optical path to determine the first distance.

42. The device of claim 34, wherein the first average spatial dimension of the speckles is selected from the group consisting of about 10 microns and ranging between about 50 microns and about 100 microns.

43. The device of claim 34, wherein the plurality of light sensors comprises at least five light sensors.

44. The device of claim 34, wherein the first signal is a high signal and the second signal is a low signal.

45. The device of claim 34, wherein the second signal is a high signal and the first signal is a low signal.

46. The device of claim 34, wherein the processor is further configured to detect leading edges of the plurality of first and second signals generated by the plurality of light sensors.

47. The device of claim 34, wherein the processor is further configured to detect trailing edges of the plurality of first and second signals generated by the plurality of light sensors.

48. The device of claim 34, wherein the first average spatial dimension of the speckles is at least twice that of the second spatial dimension of the sensors.

49. The device of claim 34, wherein the device is a mouse.

50. The method of claim 21, wherein the first average spatial dimension of the speckles is at least twice that of the second spatial dimension of the sensors.

Evidence Appendix

None.

Related Proceedings Appendix

None.